Oceanographic DataLink (ODL)

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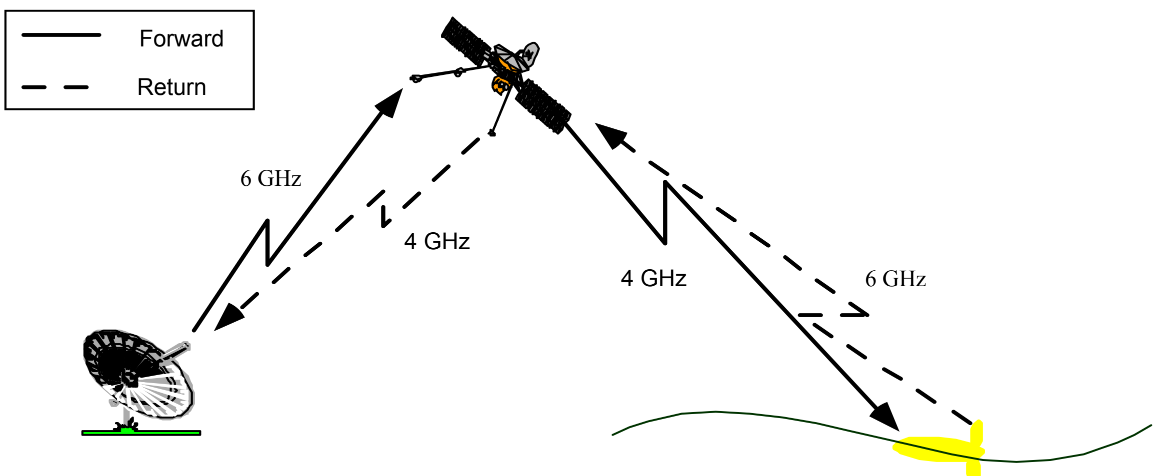
LONG-TERM GOAL

ViaSat's long-term goal is to develop and demonstrate a global two-way datalink for collection of environmental data from platforms at sea. The datalink would provide 10 to 100 times the capacity of ARGOS at a fraction of the yearly cost, and system capacity can be increased incrementally. This datalink uses existing commercial, geostationary satellites.



OBJECTIVES

The work described here builds on a Phase II Small Business Technology Transfer (STTR) effort N00014-98-C-0324. The objective of the STTR was to demonstrate the proposed datalink on an AUV. The initial effort focused on using a directional antenna and taking advantage of the positioning ability of the AUV to point the antenna. This work has been expanded to address both AUV and buoy applications. N00014-01-C-0277 focuses on the use of an "omni-directional" antenna and radome that can be more readily integrated into AUV and buoy systems. N00014-02-C-0327 focuses on the AUV application, with a simple directional antenna design that can reduce the energy required for communications, and some additional packaging to protect the terminal electronics when the AUV submerges.

APPROACH

The datalink is based on the Remote Environmental DataLink (REDL) design developed under a previous ONR SBIR. The approach has been to use the modem and hub developed under this SBIR as

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14. ABSTRACT
ViaSat???s long-term goal is to develop and demonstrate a global two-way datalink for collection of environmental data from platforms at sea. The datalink would provide 10 to 100 times the capacity of ARGOS at a fraction of the yearly cost, and system capacity can be increased incrementally. This datalink uses existing commercial, geostationary satellites.

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the common design for a number of prototype tests and demonstrations to be conducted under these and related efforts.

Over the last four years, ViaSat has finished this design, conducted hardware, developed and integrated software, completed in-lab testing and executed a number of successful off-site demonstrations.

Demonstrations to date include a one-way demonstration at the AUV Fest in November 1999, an in-water demonstration using AUSI's Energy System Testbed (EST) in February 2000, several fixed site remote demonstrations in the fall of 2000 and a return to the AUV fest in 2001 to demonstrate two-way messaging with the equipment packaged in a RACOM III buoy, on the research vessel Gyre. Further demonstrations are planned under N0014-02-C-0327.

A principle remaining goal is to integrate Turbo codes into the current prototype to support operation with an "omni-directional" antenna. An "omni-directional" antenna provides less gain, but Turbo codes cut the required energy in half. Addition of Turbo codes, together with some other system changes should allow communication to existing geostationary satellites using such antennas.

A goal of the newest contract is to demonstrate a two-way link on an AUV, with a new directional, two-way antenna, and all components capable of submersion to 30 meters.

WORK COMPLETED

In previously years the terminal design, integration, and test were completed along with the installation and test of the 4.5m demonstration hub. Access to INTELSAT 801 was authorized and considerable in-lab testing was completed. Many system issues were addressed, and several successful off site demonstrations were completed. The software for the Turbo code was developed but still required an improved modem board, the Turbo modem, to actually run in the system.

The focus of efforts in the last year was to continue work on the integration of Turbo codes and continue to do demonstrations. We did have one demonstration, but the other activities varied from this plan, for reasons described below. However, our overall understanding of all aspects of the system and options for developing the system was improved.

This year we also returned to the AUV fest to demonstrate two-way messaging with the equipment packaged in a RACOM III buoy, using a directional antenna. This demonstration was successful: Messages were sent and received. Two issues were identified – antenna pointing and a thermal problem.

The pointing issue was due to the relatively narrow beam of our test antenna, and the fact that the Gyre's motion at anchor spanned about 80 degrees. This would not be an issue with an omni, or with the less directional antenna we would use on an AUV since an AUV can maintain a heading with reasonable accuracy.

The thermal problem was related to the inefficiency of the C-band power amplifier, which generates significant heat when transmitting. Since the buoy is sealed there is no airflow, and there was poor thermal conduction to the top plate of the buoy assembly. This was addressed through some mechanical changes. Other electrical and mechanical changes were made, including the creation of

some small circuit boards to eliminate a number of connectorized components. This reduced the number of cables, freed up some space, and improved electrical performance.

Several quadri-filar helix "omni-directional" antennas had been delivered in the previous year. An antenna radome for the omni, capable of operation down to 100m, was also received. Manufacturer data for the omnis was not consistent, which led us to question the ability of the omni to operate in a satellite global beam, which is the most preferred option.

In the past year, we were able to characterize a number of omni and directional antennas over the link. One of the quadri-filar helixes performed nearly as hoped, but the other was clearly defective. We were also able to evaluate a flat, patch-based hemi 'disk' that performed fairly well.

During the previous year the Turbo modem design (board and FPGA) was completed, laid out, fabricated, and initial board level tests completed. During this year, hardware testing of the board was completed, with significant software support.

Testing with Turbo Codes was not completed for several reasons. In the previous year, ViaSat had to replace the lead hardware engineer on this effort, which delayed the effort by 9 months. Also, the inconsistency in the manufacturer data for the quad helix antennas mentioned above led us to consider other antenna alternatives to provide gain, such as a patch or dual patch antenna for AUVs, and a 'smart' antenna for buoys.

We continued to address the fact that the acquisition algorithms needed to be improved (Turbo codes can give better performance only if the signal can be initially acquired, and the signal becomes harder to acquire with an omni). We had previously identified acquisition algorithms in need of work, but this year we were able to expend additional effort simulating several acquisition approaches, as well as studying system requirements and options in support of reduced cost and better/faster signal acquisition.

One system issue that impacts acquisition is the quality of the references oscillator. Considerable effort was expended in understanding cost/performance trade-offs. Multiple candidate oscillators were identified and tested. The best of these was integrated into the prototypes, allowing us to decrease the bit rate, which is a helpful option in supporting of the omni solution.

We also revisited our link budgets, analyzing a couple of different satellites and transponders, with both global and hemi beams.

The contract for additional AUV antenna development and testing was received very recently, and we have had some discussion with antenna vendors, and explored numerous under-sea housing options.

RESULTS

We achieved a better understanding of the system requirements for support of Turbo codes and operation with an omni antenna. This involved simulations of the acquisition algorithms including analyzing the impact of the reference oscillator on the ability to acquire. In addition, we recognized that some reference oscillator specifications could be relaxed to reduce cost, but only if acquisition was modified.

The ability to reduce symbol rate is limited by the reference oscillator stability, and we have identified a cost-effective candidate. Halving the rate and adding Turbo codes will allow the system to operate with 6-7 dB less signal, which is about the difference in gain between the patch and the quad helix.

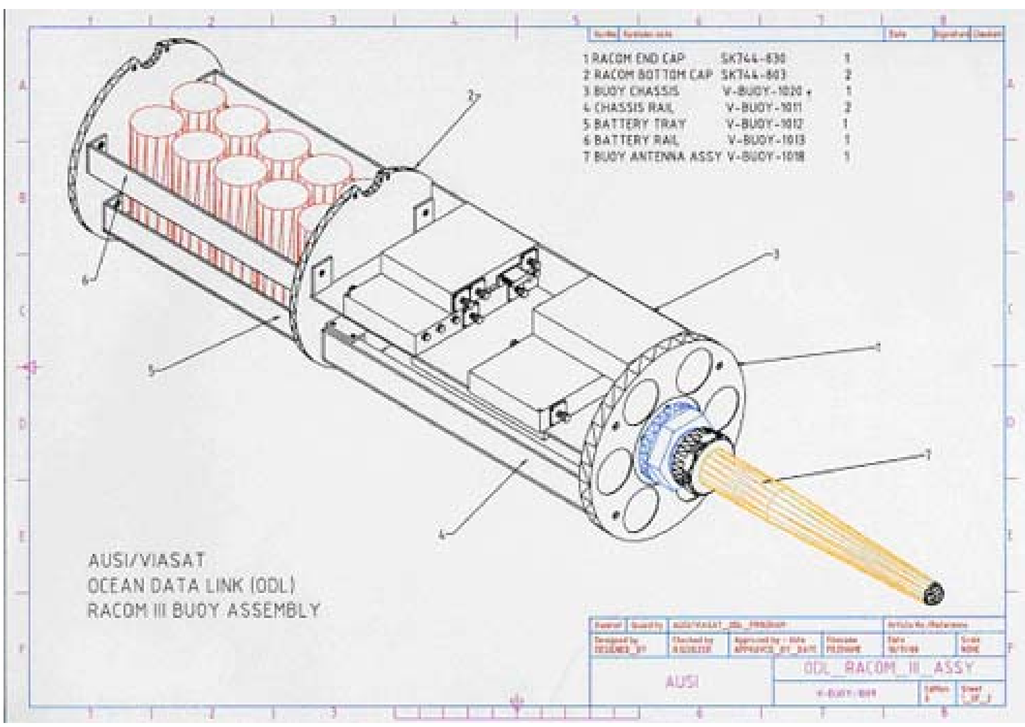
We developed a code set for a lower symbol rate. Link tests verified that our tracking algorithm needs improvement at the lower rate. This was not a big surprise since the current solution is ad-hoc. The improved reference oscillator allowed us to disable this function and see acquisition actually improve slightly at the lower symbol rate.

We also improved our understanding of antenna options, and were pleased with the performance of the disk hemi, a vendor sample.

By revisiting the link budgets, we were able to get a slightly better handle on our current and future options for satellite leases.

Finally, the mechanical and electrical improvements to the prototypes put us in a better position to continue testing and development.

In summary, we were able to improve the prototypes, finish the Turbo modem hardware testing, and focus on several key system issues that affect the implementation details in a deployed system.



IMPACT/APPLICATION

Successful commercialization of this technology would provide oceanographers the biggest advancement in telemetry in decades. Communication has long been a bottleneck for oceanographers and with recent advances in sensors and systems; even more capacity is needed to effectively use these new tools.

Previous systems were inadequate (GOES and Argos), and recent systems have gone through bankruptcy and have an uncertain future (Iridium & Orbcomm). Both of the latter do continue to function, and provide limited solutions today. However, the future of these systems is not assured because the current operators acquired the assets at near-zero cost, and will need significant capital to replace satellites in the future. In addition, the message costs are high, and total capacity is limited. ODL provides a low cost, low risk solution for oceanographic applications that can help to relieve the telemetry bottleneck.

Commercialization will require significant commitment and investment, but would not even be a consideration without the results of this development effort. This effort has demonstrated the technical feasibility of the datalink and attracted considerable customer attention. Commercialization would not be possible without this confirmation and interest.

This technology is the basis for four different products; oceanographic, tactical, fixed, and mobile. A common architecture supports all four products, but further development and demonstration is crucial even as the commercialization process moves forward to assist in analyzing and demonstrating oceanographic unique capabilities.

TRANSITIONS

ViaSat is leveraging a past design and common requirements to effectively utilize limited government resources to achieve demonstrations not possible within the cost constraints of the current efforts.

There is already considerable interest in the oceanographic and government community in demonstrating this technology in a variety of applications. Funding has been added to enhance the capabilities of the planned datalink and to support additional demonstrations. The planned demonstrations are key to continued interest and funding in this technology.

A business plan has been generated describing a compelling business case for this technology. There are number of markets covered by four different products. The oceanographic market and the ODL product are key to this business plan. ViaSat is currently considering a number of funding options to commercialize this technology. ViaSat has already received non-STTR/SBIR funds to continue the datalink development, but commercialization of the technology would be the ultimate STTR/SBIR success.

ViaSat still has considerable interest in this technology and is considering a shared government partnership to commercialize this technology. Government support would be provided through continued application-specific development. ViaSat would provide common equipment development, marketing, sales, and support.

RELATED PROJECTS

1 – GLTS (Global Location and Tracking System), an Air Force SBIR phase I and II effort to demonstrate the use of this datalink for global asset tagging and tracking. Phase I is complete, Phase II is underway. Several successful fixed site demonstrations have been completed. Joe Mancini at Air Force Rome Labs is the technical point of contact.

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